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Ticks (Ixodoidea) on Birds Migrating from Africa to Europe and Asia*

HARRY HOOGSTRAAL,[1] MAKRAM N. KAISER,[1] MELVIN A. TRAYLOR [2]
SOBHY GABER [1] & EZZAT GUINDY [1]

Hyalomma marginatum marginatum *of Europe and Asia and* H. marginatum rufipes *of Africa, both reservoirs and vectors of organisms pathogenic to humans and animals, have not infrequently been found as incidental specimens or established populations far from their normal endemic geographical boundaries. Owing to ticks' unique ability to transmit or harbour for long periods a variety of pathogens of man and animals, their potential epidemiological role is suspected wherever they occur. Evidence that birds, in themselves hosts of several viruses causing human disease, actually transport the African* H. marginatum rufipes *northwards was obtained in Egypt by capture of infested migrants during spring passage from East Africa to Europe and Asia. Between 1956 and 1960, 340 birds representing 22 forms (species and subspecies) were found infested by 1025 immature ticks, all but seven of which were or appear to be* H. marginatum rufipes. *The period of attachment of immature stages of* rufipes *to their host is sufficient to suggest that many of these ticks are carried some distance into Europe and Asia.*

INTRODUCTION

The role of northward migrating birds in long-distance and large-scale transport of immature stages of the African tick, *Hyalomma marginatum rufipes* Koch, 1844, reported herein, has epidemiological implications requiring further study in a number of disciplines and geographical areas. Southward migrating birds play a similar part in carrying the European-Asiatic tick, *Hyalomma marginatum marginatum* Koch, 1844, into Africa (Hoogstraal & Kaiser, 1961b).

Incidental specimens and established populations of both subspecies of *H. marginatum*, as well as of other tick species, have on a number of occasions been reported far from the boundaries of their endemic range. In certain areas of northern Africa and western Asia, taxonomically confusing specimens of *H. marginatum* suggest interbreeding between these two subspecies. Where endemic, both these ticks are vectors of human and animal diseases. The ability of numerous tick species to transmit or to harbour for long periods (or both) a variety of pathogenic organisms, especially viruses and rickettsiae, causes them to be suspect as reservoirs of disease-causing organisms wherever they are found. The ability of certain viruses normally transmitted by mosquitos to adapt to ticks, a definite though insufficiently studied phenomenon, further increases these suspicions, as does the still unexplained, sudden appearance of explosive, severe outbreaks of " new " tick-borne diseases, such as Kyasanur Forest disease in Mysore, India. Birds are the chief or incidental vertebrate reservoirs of a variety of viruses and rickettsiae pathogenic to man and other mammals, and isolation of certain of these pathogens from exotic foci frequently raises the question whether migrating birds, with or without ticks, have been the agents of introduction. The paucity of study on viruses in ticks and the frequency with which these arthropods are found infected when examined suggest a rich field for research.

This report on ticks taken in Egypt from birds migrating from tropical Africa to Europe and Asia is a continuation of a preliminary investigation (Hoogstraal & Kaiser, 1958b), which included data obtained during the spring passages of 1955, 1956

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[1] Department of Medical Zoology, United States Naval Medical Research Unit Number Three, Cairo, Egypt, UAR.
[2] Division of Birds, Chicago Natural History Museum, Chicago, Ill., USA.

and 1957. In the present paper, additional records for 1958 through 1960 are presented, and previous data are briefly summarized. For reasons noted below (see " Materials and Methods "), the numbers and kinds of uninfested birds examined are recorded for the 1960 migration period only. Ticks collected from southward autumn migrants are reported elsewhere (Hoogstraal & Kaiser, 1961b). All birds were taken in Cairo, Giza, or Faiyum Provinces of Egypt unless otherwise noted.

MATERIALS AND METHODS

Materials and methods used in these studies were described by Hoogstraal & Kaiser (1958a). Owing to difficulties of field identification, the species of a number of uninfested birds could not be recorded before 1960. Numerous passage birds, especially those infested by ticks, were prepared as study skins and sent to the Chicago Natural History Museum for identification. By 1960, knowledge of local migrants was sufficiently advanced to permit accurate field identification of virtually all specimens. It has been possible, therefore, to include quantitative data for both infested and uninfested birds obtained during 1960. In recent years, mist nets, in addition to previously reported baited nooses, were used to trap birds. Uninfested birds were released after examination. During 1959 and 1960, migrant and endemic kestrels were trapped by means of a mouse-baited, noose-lined cage (Berger & Mueller, 1959), which was thrown to the ground whenever one of these birds was watching.

BIRD HOSTS [1]

FAMILY ACCIPITRIDAE (HAWKS AND EAGLES)

Circus macrourus (Gmelin). Pallid Harrier. Fig. 1

This bird breeds from European USSR to Central Asia and winters throughout Africa as far south as the Cape, as well as in the Middle East and the Indian subcontinent. In Egypt it is a common spring and fall migrant and many remain for the winter. A Pallid Harrier shot at Mersa Matruh on 27 April 1959 bore three nymphs that moulted to two males and one female of *Hyalomma marginatum rufipes* on 5 June. These ticks, typical of population samples from tropical Africa, differ from those comprising more variable populations of *rufipes* in north-western Egypt. It therefore appears that the host was a migrant, not one that had overwintered in Egypt.

FAMILY FALCONIDAE (FALCONS)

Falco naumanni Fleisher. Lesser Kestrel. Fig. 2

A resident of north-western Africa and southern Europe to eastern Asia, the Lesser Kestrel winters in tropical Africa from Ethiopia to the Cape, in Arabia and in India. Eastern Asiatic populations have been classified as subspecies *pekinensis*, a probably unsatisfactory race, which Meinertzhagen (1930) listed only once from Egypt. In Egypt, *F. naumanni* is much more common in spring than in fall passage. Large numbers move northwards through the Nile Delta from early March to late April.

Two Lesser Kestrels trapped on 2 April and 10 May 1959 each bore single nymphs that moulted to females of *H. marginatum rufipes* on 18 May and 22 June. Forty-five other Lesser Kestrels taken during spring passage between 1956 and 1959 were uninfested. In 1960, 21 spring migrants were examined. One bore two nymphs appearing to be those of *rufipes*. It is particularly noteworthy that only three of 68 (±4%) spring passage *F. naumanni* were tick-infested while 42 of 82 (±50%) European Kestrels, *F. t. tinnunculus*, were infested (see below).

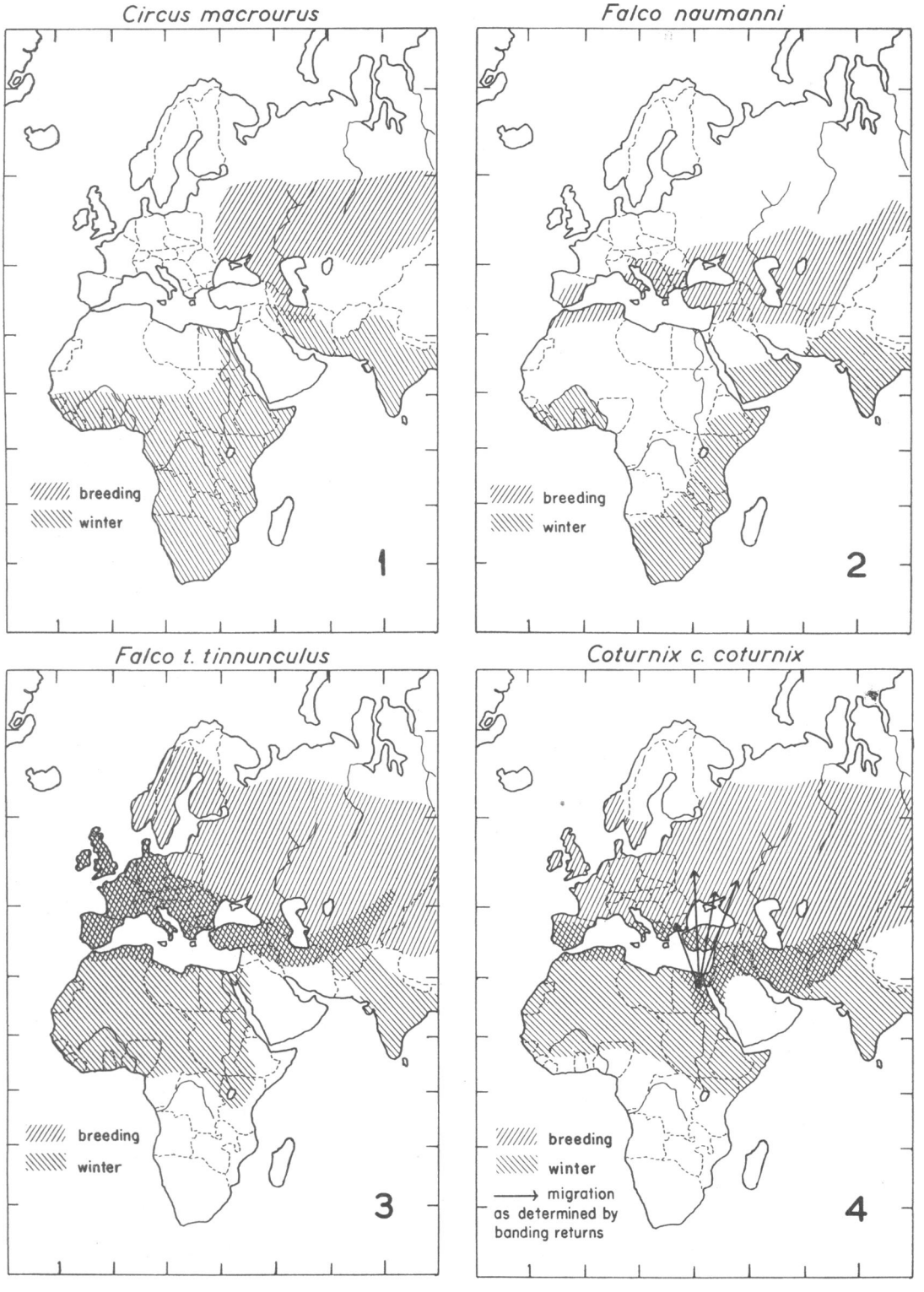
Falco tinnunculus tinnunculus Linnaeus. European Kestrel. Fig. 3

The European Kestrel, which breeds through most of Europe, eastern Asia and north-western Africa, winters from the southern part of its breeding range to equatorial Africa and India. Although a common spring migrant, this bird is rare in Egypt in the fall, although a few remain as winter visitors. European Kestrels passing through Egypt probably breed in eastern Europe and European USSR. Meinertzhagen (1930) considered the form *tinnunculus* to be uncommon in Egypt at all times. However, a long series of specimens trapped near Cairo during the past six years indicates that it is a common migrant from mid-March to early May.

Difficulty in distinguishing between the European subspecies *tinnunculus* and the Egyptian subspecies

[1] The winter and summer ranges of bird hosts of ticks are shown, for each of the avian species discussed, in Fig. 1-20 on the following pages.

FIG. 1-4. WINTER AND SUMMER RANGE OF TICK HOSTS



rupicolaeformis has been mentioned previously (Hoogstraal & Kaiser, 1958b). This problem has been solved by study of fresh series of breeding Egyptian birds, and it is now possible to identify all kestrels examined, whether bearing ticks or not.

Forty migrating *F. t. tinnunculus* were trapped in March and April, between 1956 and 1959. Thirty of these, obtained between 23 March and 10 April, were carrying a total of 44 nymphs, two of which died in this stage. The remaining nymphs moulted to 19 males and 23 females of *H. marginatum rufipes* between 6 May and 5 June, with the exception of three (one male, two females) that moulted on 22 June. In addition, three rhipicephaline nymphs on these birds moulted to two males and one female of *Rhipicephalus s. sanguineus.*

In 1960, between 9 April and 2 May, 42 *Falco t. tinnunculus* were examined. Twelve of these bore 50 nymphs, of which 27 (apparently all *H. marginatum rufipes*) died in this stage, and the remainder moulted to 13 males and 10 females of *rufipes.* A single larval *Argas* taken from one bird was too badly damaged during removal to identify as to species.

It will be noted that between 1956 and 1959, 30 of 40 (75%) *tinnunculus* were found infested, while in 1960 the incidence was 12 of 42 (28.6%). The 30 hosts of previous years carried 44 nymphs (1.5 per host), while the 12 hosts of 1960 carried 50 nymphs (approximately 4 per host). In 1960, 27 of the 50 nymphs died before moulting to adults but earlier only two of 44 died as nymphs. As noted above, the rate and incidence of tick infestation of *Falco t. tinnunculus* was much higher than that of *F. naumanni.*

FAMILY PHASIANIDAE (QUAILS AND PHEASANTS)

Coturnix coturnix coturnix (Linnaeus). European Quail. Fig. 4.

The European Quail breeds through most of Europe and western Asia and winters from Mediterranean countries south to central Africa and the plains of India. In Egypt, it is a regular breeding bird and a common migrant in September-October and from late March to early April. Migration is on a broad front, although numbers diminish rapidly west of Mersa Matruh. From banding returns (Mackintosh, 1941), it appears that quail travelling through Egypt breed in south-west Russia from the Crimea and Black Sea coast north to 57°N., and migrate either through the Balkans or down the eastern coast of the Mediterranean. Although it is impossible to determine from external characters whether an individual spring quail is a resident or migrant, it is often possible to do so from the circumstances under which it was captured. Thus, a specimen taken on 24 March 1958 in open country near the desert edge was almost certainly a migrant; breeding birds are confined to cultivated fields with dense cover. This quail was infested by five nymphal ticks that moulted to two males (25 April) and three females (27 April) of *H. marginatum rufipes.*

FAMILY COLUMBIDAE (PIGEONS AND DOVES)

Streptopelia turtur subsp. Turtle Dove. Fig. 5

The nominate race of *S. turtur* breeds in Europe, western Russia and the Near East; the paler subspecies *arenicola* breeds in western North Africa and in western Asia and Iran. Both forms winter together in tropical Africa north of the equatorial forests.

The subspecies *turtur* is a common migrant in Egypt in both spring and fall but *arenicola* appears to be rare in fall although common in spring. The two races evidently travel in mixed flocks since specimens of both were collected from the same tree at Mersa Matruh in April. Although extremes of the two races are easily separated, many specimens are intermediate in colour and cannot be allocated to subspecies. Three Turtle Doves shot at Wasta, south of Cairo, on 30 April 1958 were infested by three tick larvae that appear to be those of *H. marginatum rufipes.*

FAMILY MEROPIDAE (BEE-EATERS)

Merops superciliosus persicus Fallas. Blue-checked Bee-eater. Fig. 6

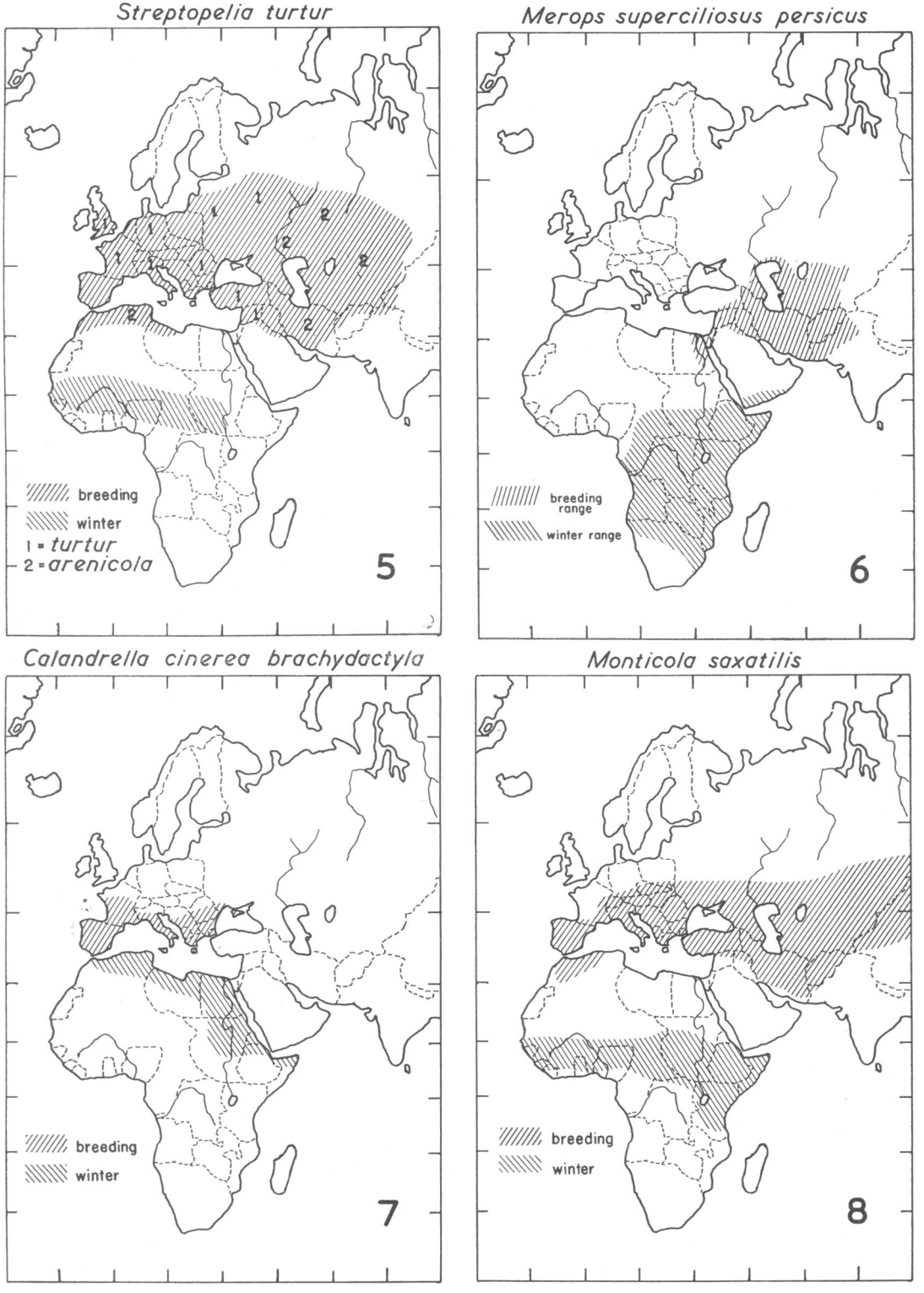
These birds, which breed from southern USSR to the eastern Mediterranean coast and Egypt and east to north-western India, winter in Africa from central Sudan to South Africa and southern Arabia. They are both summer residents and passage migrants in Egypt, but do not winter there. Specimens taken in spring must therefore have come from south of the Sahara. Thirteen bee-eaters were examined in the vicinity of Cairo between 22 March and 10 April 1960. One of these bore a nymph that moulted to a female *H. marginatum rufipes.*

FAMILY ALAUDIDAE (LARKS)

Calandrella cinerea brachydactyla (Leisler). Mediterranean Short-toed Lark. Fig. 7

This bird breeds across southern Europe from Spain to the Crimea and winters in northern Africa, Sudan and Somaliland. In Egypt, it is a common

FIG. 5-8. WINTER AND SUMMER RANGE OF TICK HOSTS



spring and fall migrant, a few remaining to winter. Large numbers appear near the Cairo area in spring. One bird taken from a migrating flock on 5 April 1956 bore two nymphs that moulted to females of *H. marginatum rufipes* on 12 May. These adults were typical of East African *rufipes* populations.

FAMILY TURDIDAE (THRUSHES, CHATS, ETC.)

Monticola saxatilis (Linnaeus). Rock Thrush. Fig. 8

The Rock Thrush breeds in isolated mountains of Europe, southern USSR, Asia Minor, Lebanon, Iran, Baluchistan to China, and in Morocco and Algeria. It is nowhere common. A strong migrant, it winters almost entirely in Africa, a remarkable example of winter concentration from a wide breeding area. Spring passage in Egypt is very marked from late March to late April. Birds from eastern Asia probably fly through Iran and southern Arabia into East Africa while those passing through Egypt probably breed in eastern Europe and western USSR.

Seven infested Rock Thrushes were trapped between 20 March and 11 April in 1956, 1958, and 1959. Fourteen nymphs taken from them moulted to three males and 11 females of *H. marginatum rufipes*. The dates of moulting were between 12 April and 15 May. In 1960, 23 Rock Thrushes were examined. Four of these bore 10 ticks, two larvae and eight nymphs, of which two moulted to a male and a female of *H. marginatum rufipes*; the remainder appear to be the same form. These birds were trapped between 17 March and 7 April. One infested host was taken on the first day and three on the last day.

Oenanthe oenanthe oenanthe (Linnaeus). European Wheatear. Fig. 9

The European Wheatear breeds throughout most of Europe, east to central and northern Asia and northern Alaska, and in Corsica and northern Israel and Jordan, but not in Cyprus or Crete. It migrates to Arabia, Africa south to the Zambesi River, and India and the Philippines (only the African range is shown on the map). Passage migrants through Egypt, from early March to late May, are especially abundant from mid-March to mid-April. The breeding range of European Wheatears transiting Egypt is probably the area from eastern Europe to the Urals in USSR.

Thirty-two infested hosts trapped in March and April of 1956 yielded 59 nymphs that moulted to 20 males and 39 females of *H. marginatum rufipes* between 1 and 23 May. In addition, 112 immature *Hyalomma* ticks, 66 larvae and 46 nymphs, taken on these birds died before reaching the adult stage. Eleven of the 32 hosts were infested by the 112 immature specimens that died; among them five were infested by 6-58 larvae and nymphs. The other 27 hosts, infested by fewer than six and mostly by one or two ticks, provided more vigorous specimens with low mortality.

From 1957 to 1959, between 6 March and 21 April, 23 *Hyalomma*-infested European Wheatears bore two larvae and 27 nymphs of which the two larvae and six nymphs died and 11 males and 10 females of *H. marginatum rufipes* moulted between 25 April and 14 May. One of the nymphs that died was infested by *Hunterellus theilerae* (Hoogstraal & Kaiser, 1961a).

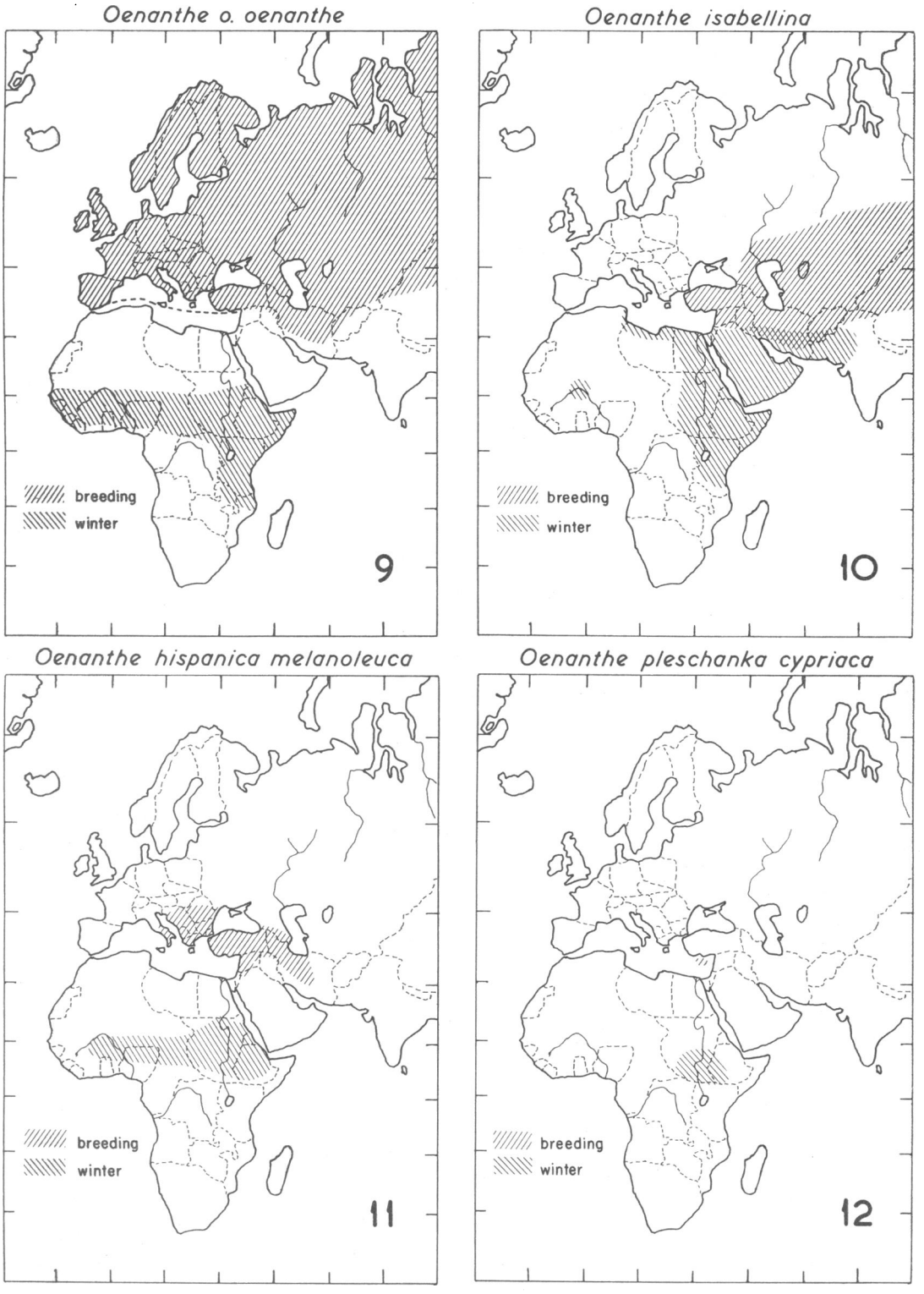
In March and April of 1960, 270 European Wheatears were examined. Of these, 48 were infested by 111 larvae and nymphs (probably mostly *H. marginatum rufipes*), and 27 other nymphs that were reared to 15 males and 12 females of *H. marginatum rufipes*. Thus, between 1956 and 1960, 103 infested birds of this species yielded 338 immature *Hyalomma* ticks. A larval *Argas* sp. was also taken from one of these wheatears in 1960.

Oenanthe isabellina (Temminck). Isabelline Wheatear. Fig. 10

This bird breeds from Asia Minor and the Caucasus eastward to Lake Baikal and Kansu; those passing through Egypt probably breed west of longitude 75°E. The winter range includes northern India, Arabia, Egypt, Sinai, Sudan and East Africa as far south as Tanganyika. Northward passage in Egypt occurs between mid-March and early May. A few remain in winter but only birds taken from large flocks during the peak migration period have been considered below.

Between 1956 and 1959, 70 infested hosts were taken during the months of March and April. These were infested by 233 *Hyalomma* ticks as follows: 140 nymphs reared to 66 males and 74 females of *H. marginatum rufipes*, two nymphs reared to females of *H. impeltatum*, and 25 larvae and 68 nymphs (apparently mostly *H. marginatum rufipes*) that were not reared. All nymphs had moulted to adults by 21 May. Three of the nymphs that died were infested by *Hunterellus theilerae* (Hoogstraal & Kaiser, 1961a). A few birds of this species were heavily infested, one having yielded 103 nymphs and others 12 and 26 nymphs, but usually the rate was from one to three ticks per bird.

FIG. 9-12. WINTER AND SUMMER RANGE OF TICK HOSTS



In March and April, 1960, 158 Isabelline Wheatears were examined. Eighteen of these were infested by 40 ticks from which four male and three female *H. marginatum rufipes* were reared and seven larvae and 26 nymphs appearing to be the same form of tick were preserved.

Oenanthe hispanica melanoleuca (Güldenstädt). Black-eared Wheatear (Eastern form). Fig. 11

This bird breeds from Italy through Asia Minor eastward to the longitude of the Caspian Sea. It winters in southern Egypt, Sudan, Ethiopia, and the Red Sea coast and is abundant as a migrant in northern Egypt from early March through late April.

Fourteen infested Black-eared Wheatears taken in late March and April between 1955 and 1959 were infested by 121 ticks. Ten males and eight females of *H. marginatum rufipes* were reared from nymphs; an additional 38 nymphs and 65 larvae appeared to be this form of tick.

Between 9 March and 15 April 1960, 81 Black-eared Wheatears were examined. Fourteen were infested by 21 ticks. Two male and one female *H. marginatum rufipes* moulted from nymphs and nine larvae and nine nymphs appearing to be those of *rufipes* were preserved. Differences in levels of infestation are noteworthy: between 1955 and 1959 the rate was approximately 8.6 per bird while in 1960 it was 1.5 per bird.

Oenanthe pleschanka cypriaca (Homeyer). Cyprian Pied Wheatear. Fig. 12

A breeding bird of the island of Cyprus, this Wheatear winters in southern Sudan and Ethiopia. Previously known in Egypt only as a rare fall migrant, the Cyprian Pied Wheatear also passes through the Cairo area in small numbers in spring, as indicated by the following collections.

Two specimens trapped on 16 April 1958 and 15 April 1959 yielded three nymphs that moulted to two male and one female *H. marginatum rufipes* on 19 May 1958 and 18 May 1959. Between 18 March and 12 April 1960, 13 of these birds were examined and four were found bearing two larvae and five nymphs. A male and female *H. marginatum rufipes* were reared. The remaining two larvae and three nymphs appear to be the same form of tick.

Phoenicurus phoenicurus phoenicurus (Linnaeus). Common Redstart (Western Form). Fig. 13

The Common Redstart breeds throughout the whole of Europe and in Central Asia east to the Yenesei. It winters in Arabia and tropical Africa approximately to the equator. Spring migrants are abundant in Egypt from mid-March to early May.

Seven infested hosts, trapped between 23 March and 26 April in 1956, 1957, and 1958, bore nine nymphs that moulted to five male and four female *H. marginatum rufipes*. Between 9 March and 29 April 1960, 53 Common Redstarts were trapped. Six of these bore eight nymphs, two of which moulted to males of *H. marginatum rufipes*; six nymphs were preserved as probably this form. One of the nymphs that died was infested by *Hunterellus theilerae* (Hoogstraal & Kaiser, 1961a).

FAMILY SYLVIDAE (WARBLERS)

Erythropygia galactotes galactotes (Temminck). Rufous Warbler. Fig. 14

The Rufous Warbler, which breeds from southern Spain and Portugal through littoral northern Africa to Palestine, southern Syria and northern Sudan, winters in Sudan, Ethiopia and Somaliland. It is a summer visitor in Egypt along the Mediterranean littoral, in the Nile Delta, Upper Egypt, oases, and northern Sinai. Earliest arrivals near Cairo appear about 12 March and migrants become more numerous early in April. Those that remain here for the summer depart in September. Birds reported below were taken from large flocks and bore ticks typical of East African populations, suggesting that they were new arrivals.

Three Rufous Warblers trapped between 9 and 12 April 1956 were infested by 14 nymphs that moulted to three males and eight females of *H. marginatum rufipes*; the remaining three nymphs died in the nymphal stage.

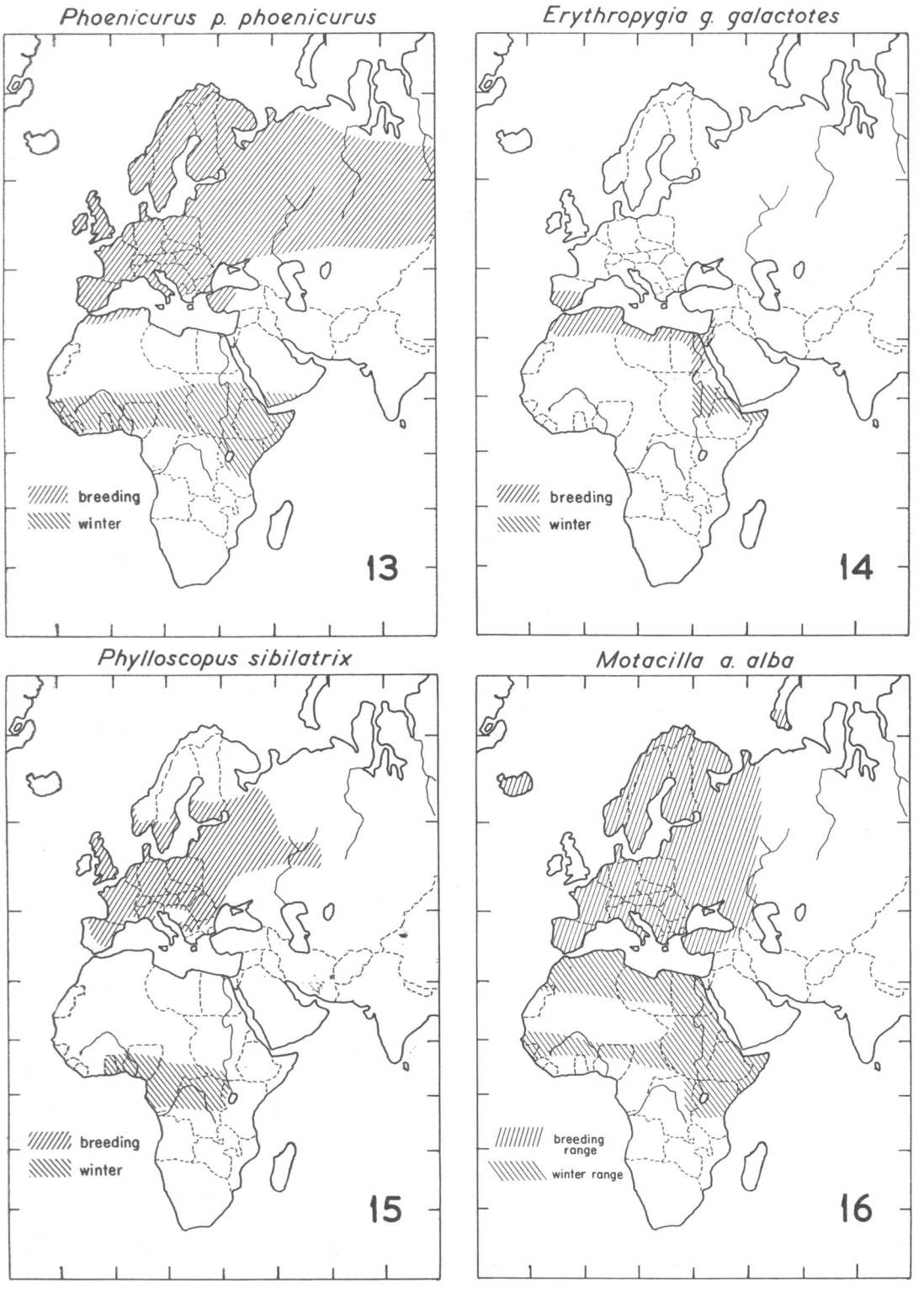
In April and May of 1957 to 1959, six infested migrating Rufous Warblers yielded eight nymphs, one of which died; the others moulted to three males and four females of *H. marginatum rufipes*. In 1960, 56 of these birds were examined. Eleven were infested by 21 nymphs and five larvae; a male of *H. marginatum rufipes* was reared and the remainder appear to be this form of tick.

Phylloscopus sibilatrix (Bechstein). Wood Warbler. Fig. 15

The Wood Warbler breeds through much of Europe and European Russia. It winters in Africa in a narrow band of wooded savannah north of equatorial forests. It is a rare migrant in Egypt in autumn but many pass through in spring between late March and late April.

The single tick host of this species, taken at Mersa Matruh on 27 April 1959, in all probability flew

FIG. 13-16. WINTER AND SUMMER RANGE OF TICK HOSTS



directly there from French Equatorial Africa or Sudan without following the Nile Valley. It bore a single larva that appears to be *Hyalomma marginatum rufipes*.

FAMILY MOTACILLIDAE (WAGTAILS AND PIPITS)

Motacilla alba alba Linnaeus. White Wagtail. Fig. 16

The White Wagtail breeds in Europe eastward to the Urals and south to Syria; it winters from southern Europe to central Africa and Iran. In Egypt, it is a winter visitor whose numbers are augmented in spring and fall by passage migrants.

Eleven White Wagtails appearing to be obvious migrants were examined from 21 to 23 March 1960. One bird bore two nymphs that appear to be *H. marginatum rufipes*.

Motacilla flava feldegg Michahelles. Blackheaded Wagtail. Fig. 17

A resident of the area between Greece, Turkey and Syria to the Black Sea and Caspian Basin (including Iran and northern Afghanistan), this bird winters in Africa to beyond the equator, although rarely to South Africa. Though more common in Egypt during autumn than spring passage, the Blackheaded Wagtail rarely passes through the Nile Valley and Delta. The peak of spring migration is from 11 March to 7 April (Meinertzhagen, 1930).

The single tick host, a fairly late migrant, was taken at Mersa Matruh on 26 April 1959. It carried two nymphs that appear to be *H. marginatum rufipes*.

Anthus campestris campestris (Linnaeus). Tawny Pipit. Fig. 18

The Tawny Pipit breeds through most of Europe to western Siberia and winters in Africa north of the equator. Spring migration in Egypt is from late February to late April; fall migration from late August to early October. Spring migrants noted below were taken in April from large flocks on the desert edge, a situation avoided by winter residents.

Three Tawny Pipits taken during the first half of April in 1956 and 1959 yielded three nymphs that moulted to two males and one female of *H. marginatum rufipes* between 14 and 16 May. In 1960, two of 35 were infested; they bore six nymphs, of which one moulted to a male of *H. marginatum rufipes*.

FAMILY LANIIDAE (SHRIKES)

Lanius nubicus Lichtenstein. Masked Shrike. Fig. 19

The Masked Shrike breeds from Asia Minor to southwestern Iran and winters in Iraq, Arabia, Somalia, Ethiopia, and Sudan. A few winter in southern Egypt. In the Cairo area, it is more abundant in spring passage, 12 March to 25 April, than in autumn passage.

A nymph removed from a Masked Shrike on 21 March 1956 moulted to a male of *H. marginatum rufipes* on 23 May. One bird examined in 1960 was uninfested by ticks.

Lanius senator senator Linnaeus. European Woodchat Shrike (Western Form). Fig. 20

This shrike breeds in southern Europe and western Asia Minor. The eastern race, *niloticus*, breeds in the Near East and Iran. The area between these ranges, the Caucasus and eastern Turkey, is inhabited by a broad band of intermediate populations. Both *senator* and *niloticus* winter together in East Africa north of the equator. The nominate subspecies is abundant in Egypt on spring passage, 16 March to 22 April, but rare in autumn and absent in winter.

Two Woodchat Shrikes (western form), taken on 11 March 1956 and 8 May 1959, were infested by single nymphs that moulted to a male and female of *H. marginatum rufipes* on 12 May and 5 June, respectively. In 1960, none of five birds of this form that were examined bore ticks.

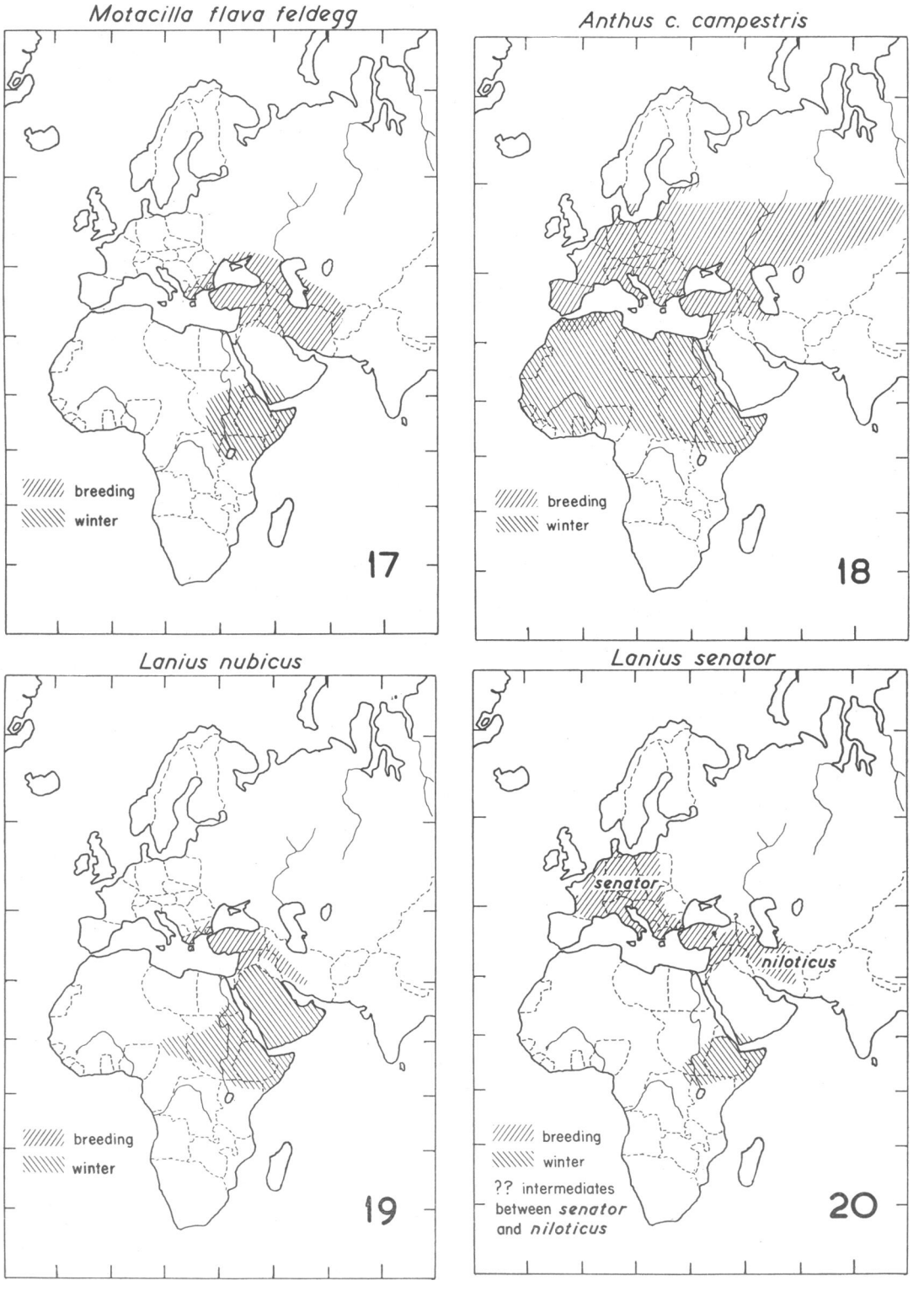
Lanius senator niloticus (Bonaparte). European Woodchat Shrike (Eastern Form). Fig. 20

For winter and summer distribution, see *Lanius s. senator*, above. A specimen of the subspecies *niloticus* trapped on 24 March 1958 was infested by two nymphs that moulted to a male and a female of *H. marginatum rufipes* on 1 May. In 1960, 10 *niloticus* were examined between 19 March and 12 April. Six of these, between 27 March and 12 April, bore 34 ticks, three larvae and 31 nymphs. Four male and three female *H. marginatum rufipes* were reared from nymphs; the remainder of immature specimens appear to be the same form.

Lanius senator senator $\gtrless$ *niloticus*. European Woodchat Shrike (either Eastern or Western Form). Fig. 20

For distribution of intermediate forms of the European Woodchat Shrike, see *Lanius s. senator*, above. A single intermediate form taken on 14 March 1957 bore a nymph that dropped on 18 March and moulted to a male of *H. marginatum rufipes* on 23 April.

FIG. 17-20. WINTER AND SUMMER RANGE OF TICK HOSTS



DISCUSSION AND CONCLUSIONS

MIGRATION ROUTES AND DESTINATIONS

Migration routes of a few species, such as the white stork *(Ciconia ciconia)* and swallow *(Hirundo rustica)*, can be plotted from returns of birds banded in Europe. Banding of palaearctic migrants on their African wintering grounds has recently begun. Few returns are thus far available to assist us with problems of passage migrants in Egypt. Despite this lack of direct evidence, some claims can be made with relative certainty.

The great volume of birds that descend the Nile Valley in spring and migrate through the Delta have either passed through or wintered in Sudan. A few, such as *Motacilla flava feldegg* and *Phylloscopus sibilatrix*, may have crossed the Sahara from equatorial Africa, but the majority will have followed the Nile flyway from the savannahs of central Sudan. Study of distribution maps (Fig. 1-20) of tick host species shows that all but *Falco naumanni* have been recorded as wintering in at least part of Sudan. *F. naumanni*, however, passes through Sudan in large numbers in spring.

A second area from which migrants flying over Egypt might be expected is East Africa. At least 12 of the 22 tick host forms (species and subspecies) winter in Uganda, Kenya, and northern Tanganyika. There is less assurance that the bulk of East African birds migrate through Egypt during spring. However, it is safe to assume that during the passage north some if not many of those wintering to the south join those returning from Sudan.

Although their actual wintering grounds are unknown, a few birds passing northwards through Egypt are representatives of species found as far south as the Cape of Good Hope. These species are *Falco naumanni*, *Circus macrourus*, and *Merops superciliosus persicus*. Until rings of birds taken on the African continent are reported, precise information on overwintering localities of numerous populations will remain obscure.

Summer breeding areas to which tick-infested birds were flying when intercepted in Egypt appear to be mostly eastern Europe and western USSR. Some go at least as far the eastern shores of the Black Sea, others may travel even further into the interior of Asia.

PATTERN AND PERIOD OF MIGRATION

Spring migration in Egypt begins during the last few days of February and extends to early May. Samples for the present study were taken from the vast numbers of birds that follow the Nile Valley. That numerous migrants fly northwards over the Sahara, tarry a bit on the coast, and then take off over the ocean is shown by the great numbers seen resting on the narrow littoral desert fringe of the Mediterranean across the entire breadth of Egypt. Few of these latter birds have thus far been studied. Species and destinations of birds travelling to the east and west of the Nile probably differ from those overflying cultivated areas of Egypt.

The rate of northward migration is poorly known, though it is thought to be somewhat more leisurely than in autumn. Some bird species leaving northern Egypt fly to eastern Europe or Asia directly over water in a day or two, usually utilizing favourable oceanic winds. Others fly into Asia *via* Sinai and eastwards.

LIFE-CYCLE OF *H. MARGINATUM RUFIPES*

Hyalomma marginatum rufipes appears to act as a two-host tick when its immature stages parasitize birds. Adults are usually found on larger domestic animals. Larvae and nymphs remain on avian hosts for at least two weeks and sometimes six weeks or more (Hoogstraal, 1956, pp. 487-488). It seems likely that many attached larvae or nymphs have been carried to Europe and Asia by migrating birds, and that this agency is therefore responsible for *rufipes* specimens having been found in Eurasia.

DISTRIBUTION AND ECOLOGY OF *H. MARGINATUM RUFIPES*

The normal geographic range of *H. marginatum rufipes* is the Ethiopian Faunal Region, including the highlands of south-western Arabia and scattered localities in the Nile Valley of Egypt. Egyptian populations are morphologically much more variable than are those of tropical Africa. Most Egyptian samples are easily distinguishable from those from further south in Africa.

Although the minimum temperature tolerance of *rufipes* has not been studied, Theiler (1956) reports it from South African highlands where 120 days of frost appear annually. Temperature alone does not appear to be a restrictive factor in *rufipes* distribution, since this tick also commonly occurs in semi-arid regions of Africa and in savannahs with a long, hot, severe dry season. In areas with over 30 inches (about 760 mm) of annual rainfall, semitropical zones, humid seacoasts and other zones with high relative humidity in spite of low annual rainfall, *rufipes* is less common or absent.

Areas of the USSR from which *rufipes* has been reported (reviewed by Hoogstraal, 1956, p. 489) are the western desert of Transcaucasia and mountain pastures (but not valleys) of western Tadzhikistan. Transcaucasian populations may have been established through the agency of birds travelling up the Nile flyway. Tadzhik populations may have been introduced by birds flying from South or East Africa over Arabia or the Arabian Sea to the Middle East and thence northwards into the USSR.

TICK-INFESTATION OF SPRING MIGRANTS

During the 1960 spring migration period, 959 northward migrating birds representing 29 species were examined. Data from infested species are summarized in Table 1. (Uninfested species and the number of each examined are shown below). One hundred and seventy-three birds representing 16 species were free of ticks. One hundred and twenty-eight birds, out of 786, representing 13 species, bore 349 ticks. Two of these ticks were larval *Argas* species; 347 were *Hyalomma* larvae and nymphs, from which 78 adults of *H. marginatum rufipes* were reared. The remaining ticks all appear to be *rufipes*.

The most frequently and most heavily tick-infested birds taken during the 1960 spring migration were *Falco t. tinnunculus*, *Oenanthe o. oenanthe*, *O. isabellina*, *Erythropygia g. galactotes*, and *Lanius senator niloticus*. The proportion of infested individuals was also sufficient to suggest the significant role of the following species: *Monticola saxatilis*, *Oenanthe hispanica melanoleuca*, *O. pleschanka*

TABLE 1

TICK-INFESTED SPRING MIGRATORY BIRDS IN EGYPT, 1960 [a]

Bird hosts				Ticks			
Species	No. examined	Infested		Immature *Hyalomma* spp.	*Hyalomma m. rufipes* reared	Total ticks	No. ticks per host
		No.	%				
Falco naumanni	21	1	4.8	2	2	4	4.0
Falco t. tinnunculus [b]	42	12	28.6	27	23	50	4.2
Merops superciliosus persicus	13	1	7.7	0	1	1	1.0
Monticola saxatilis	23	4	13.3	8	2	10	2.5
Oenanthe o. oenanthe [b]	270	48	17.8	111	27	138	2.8
Oenanthe isabellina	158	18	11.4	33	7	40	2.2
Oenanthe hispanica melanoleuca	81	14	17.3	18	3	21	1.5
Oenanthe pleschanka cypriaca	13	4	30.8	5	2	7	1.8
Phoenicurus p. phoenicurus	53	6	11.3	6	2	8	1.3
Erythropygia g. galactotes	56	11	19.7	25	1	26	2.4
Motacilla a. alba	11	1	10.0	2	0	2	2.0
Anthus c. campestris	35	2	6.3	5	1	6	3.0
Lanius senator niloticus	10	6	60.0	27	7	34	5.6
Total (13 host forms)	786	128		269	78	347	

[a] In addition, 173 birds, representing 16 other species, were also examined and found free of ticks.
[b] A single larva of *Argas* sp. was also taken.

cypriaca, Phoenicurus p. phoenicurus, and *Anthus c. campestris.*

Almost 300 forms of birds migrate through Egypt (Meinertzhagen, 1930). Therefore, records from the approximately 40 forms examined by us merely provide an indication of tick infestation of species obtained by the methods we used rather than an over-all picture of the subject. Different methods of trapping and netting, shooting, and more extensive work in other areas of Egypt would undoubtedly have resulted in a more diversified picture of tick-infestation. This is particularly applicable to the Sinai Peninsula, where no studies have been made. Most birds obtained during this survey were mist-netted or bait-trapped in the Cairo area.

The level of tick infestation per host in 1960 ranged between 1.0 and 5.6, usually 2 or 3. Although in earlier years, some exceptionally heavily infested birds were obtained, none in 1960 harboured an unusual number of ticks. Previously, heavy infestations were reported from *Oenanthe o. oenanthe* (112 ticks from 11 hosts), *O. isabellina* (103, 12 and 26 ticks from 3 hosts), and *O. hispanica melanoleuca* (117 ticks from 11 hosts) (Hoogstraal & Kaiser, 1958b). Thus, the level of infestation of these species during the entire period of observation (1956-60; see Table 2) is somewhat higher than that of 1960.

The species and numbers of uninfested birds examined during the spring migration period of 1960 are listed below (species that were found infested in previous years are indicated by an asterisk): *Phylloscopus c. collybita* (13), **Lanius nubicus* (1), *Monticola s. solitarius* (19), *Merops apiaster* (24), **Lanius s. senator* (5), *Neophron p. percnopterus* (1), *Buteo buteo vulpinus* (1), *Ciconia c. ciconia* (2), *Acanthus canabina mediterranica* (1), *Muscicapa s. striata* (15), *Saxicola r. rubetra* (1), *Jynx t. torquilla* (1), *Coracias g. garrulus* (1), *Upupa e. epops* (4), *Glareola p. pratincola* (3), and *Alauda arvensis cantarella* (81).

Hyalomma ticks are invariably found in, around, or near the ears of their host. With the exception of *Argas* and *Haemaphysalis* spp., which may attach anywhere on the host, most other ticks also attach to the head and it is seldom necessary to search elsewhere on the body. *Argas* ticks were found incidentally during the present study. Almost the only way to survey accurately for argasid ticks is to pluck all feathers, a technique we did not utilize.

If a captive host dies before nymphs have completed feeding, this developmental stage often dies. If, however, sufficient blood has been imbibed to permit the nymph to moult to the adult stage, resulting males and females are frequently dwarfs that may be difficult to identify. Vigorous, well-formed adult ticks develop only from nymphs that have fully fed—a process usually intensely accelerated some hours before detaching from the host.

MEDICAL IMPORTANCE OF *H. MARGINATUM RUFIPES*

Hyalomma m. rufipes has been found infected with *Rickettsia* (*Dermacentroxenus*) *conorii*, the causative organism of boutonneuse fever or tick typhus, in southern Africa. It seems probable that most species of ixodid ticks are capable of transmitting the causative *Rickettsia* (Gear, 1954). This disease, related to Rocky Mountain spotted fever of the American continent, is widely distributed in Africa from the Cape to the Mediterranean. It also occurs in southern Europe as far north as Romania, and in Crimea, Israel, and the North-West Frontier Province and Kumaon Hills of India. Coincidentally, this distributional outline conforms very closely to that of the *Hyalomma marginatum* complex. In the laboratories of the US Naval Medical Research Unit, No. 3, in Cairo, *H. marginatum rufipes* has also been found naturally infected with *Rickettsia burnetii*, the causative organism of Q fever, which is now known from many parts of the world. Reiss-Gutfreund (1956) reported isolation of *Rickettsia prowazekii* from *H. marginatum rufipes* in Ethiopia. *H. marginatum rufipes* and allied subspecies are definitely deserving of further virological and rickettsiological investigation. Some reasons for this statement are briefly reviewed in the introduction to the present report. The nominate form, *H. m. marginatum* Koch, 1844 (= *H. p. plumbeum* Panzer, 1795, of Russian workers), is the vector of the virus causing Crimean haemorrhagic fever, and has been associated, in nature and experimentally, as a vector or reservoir of a number of pathogens causing human and animal diseases.

TABLE 2
TICK-INFESTED SPRING MIGRATORY BIRDS IN EGYPT, 1956-60

Bird host species	No. hosts, 1956-60	*Hyalomma m. rufipes* reared to adults		Immature *Hyalomma* sp.[a]	Other tick species	Total ticks	No. ticks per host
		♂♂	♀♀				
Circus macrourus	1	2	1	0	0	3	3.0
Falco naumanni	3	0	2	2	0	4	1.3
Falco t. tinnunculus	42	32	33	29	3[b], 1[c]	98	2.3
Coturnix c. coturnix	1	2	3	0	0	5	5.0
Streptopelia turtur subsp.	3	0	0	3	0	3	1.0
Merops superciliosus persicus	1	0	1	0	0	1	1.0
Calandrella cinerea brachydactyla	1	0	2	0	0	2	2.0
Monticola saxatilis	11	4	12	8	0	24	2.2
Oenanthe o. oenanthe	103	46	61	231	1[c]	339	3.3
Oenanthe isabellina	88	70	77	126	2[d]	275	3.1
Oenanthe hispanica melanoleuca	28	12	9	121	0	142	5.0
Oenanthe pleschanka cypriaca	6	3	2	5	0	10	1.7
Phoenicurus p. phoenicurus	13	7	4	6	0	17	1.3
Erythropygia g. galactotes	20	7	12	29	0	48	2.4
Phylloscopus sibilatrix	1	0	0	1	0	1	1.0
Motacilla a. alba	1	0	0	2	0	2	2.0
Motacilla flava feldegg	1	0	0	2	0	2	2.0
Anthus c. campestris	5	3	1	5	0	9	1.8
Lanius nubicus	1	1	0	0	0	1	1.0
Lanius s. senator	2	1	1	0	0	2	1.0
Lanius senator niloticus	7	5	4	27	0	36	5.1
Lanius s. senator ≷ *niloticus*	1	1	0	0	0	1	1.0
Total (22 host forms)	340	196	225	597	7	1 025	

[a] Probably *Hyalomma marginatum rufipes*.
[b] *Rhipicephalus s. sanguineus*.
[c] *Argas* sp.
[d] *Hyalomma impeltatum*.

RÉSUMÉ

Les tiques sont les vecteurs connus de divers virus et rickettsies pathogènes pour l'homme. Deux espèces sont particulièrement importantes à ce point de vue; elles ont des aires de répartition géographique bien définies: *Hyalomma marginatum rufipes* Koch est une espèce africaine et *Hyalomma marginatum marginatum* Koch, une espèce d'Europe et d'Asie. La faculté propre à ces tiques d'héberger pendant de longues périodes des agents pathogènes rendent ces arthropodes suspects partout où on les rencontre, cela d'autant plus que certains virus normalement transmis par les moustiques peuvent s'adapter aux tiques.

On a découvert au cours des dernières années que des oiseaux migrateurs pouvaient transporter ces tiques hors des limites de leur habitat normal et provoquer ainsi l'extension de maladies d'un continent à l'autre. Cela permet d'expliquer l'apparition explosive de poussées de maladies transmises par les tiques, dans des régions où elles étaient inconnues, telle, par exemple, la maladie de Kyasanur Forest.

Les auteurs, qui ont poursuivi de 1958-1960 les recherches entreprises par un des leurs en 1956, ont apporté de nouvelles preuves du transport des tiques par les migrateurs, en capturant et examinant dans la zone du

Caire les oiseaux migrant au printemps de l'Afrique orientale vers l'Europe et l'Asie. De 1956 à 1960, sur 340 échantillons d'oiseaux représentant 22 espèces et sous-espèces, on a trouvé 1025 tiques aux stades de larves ou de nymphes, qui, à l'exception de sept d'entre elles, ont été considérées comme des *H. m. rufipes*. Cette espèce d'Afrique orientale, parasite des grands animaux domestiques à l'état adulte, subit les diverses phases de son développement sur les oiseaux, pendant 2-6 semaines. C'est ainsi que l'on explique son transport, et sa présence en Europe et en Asie, dans les déserts de la Transcaucasie et les pâturages montagneux du Tadjikistan. *H. m. rufipes* a été reconnue comme le vecteur de l'agent de la fièvre boutonneuse, répandue en Afrique, du Cap à la Méditerrannée et apparentée à la fièvre pourprée des Montagnes Rocheuses. Cette maladie sévit aussi en Europe (Roumanie), en Crimée, en Israël et dans l'Inde (Province frontalière du Nord-Ouest et Kumaon Hills). Ces régions sont à peu près celles où l'on a trouvé, hors de son aire habituelle, *H. m. rufipes*. Cette tique est aussi naturellement infectée par l'agent de la fièvre Q. C'est dire combien il importe de poursuivre les recherches sur les virus des tiques et le rôle des oiseaux migrateurs dans la dispersion de ces vecteurs dans le monde.

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